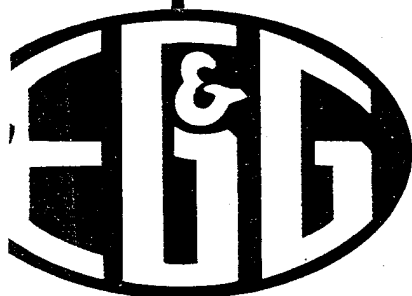


EGG
B-2063

R.A.E.



EDGERTON, GERMESHAUSEN & GRIER, INC.

FIREBALL CALCULATIONS
SHOT HUMBOLDT
OPERATION HARDTACK PHASE II
PROJECT 15.1

DISTRIBUTION STATEMENT A

Approved for public release
Distribution Unlimited

19960702 077

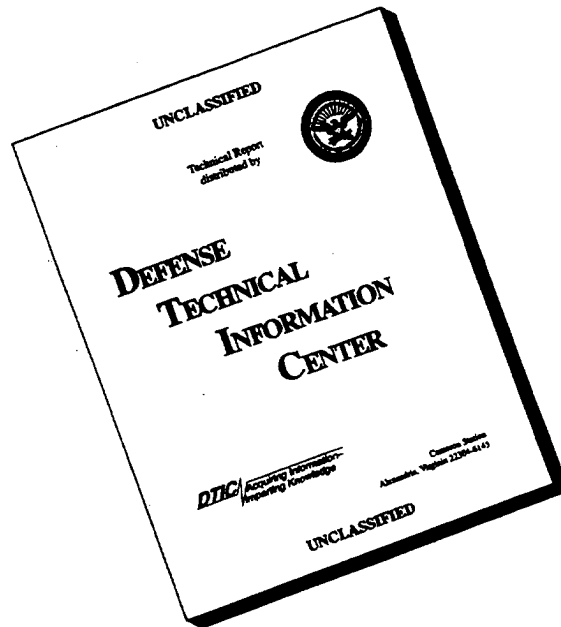
DISTRIBUTION STATEMENT A APPLIES
PER NTPR REVIEW.

Robert L. Kopp DATE 4/25/96

REPORT NO. B-2063
4 MARCH 1960

BOSTON, MASSACHUSETTS • LAS VEGAS, NEVADA
SANTA BARBARA, CALIFORNIA

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Defense Nuclear Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398



ISST

29 May 1996

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OCD/MR. BILL BUSH

SUBJECT: Documents for DTIC System

There is no record of your office receiving the following reports:

EGG-B-2064 (4 March 1960)
Fireball Calculations Shot
Wrangell Operation Hardtack
Phase II, Project 15.1

EGG-B-2063 (4 March 1960)
Fireball Calculations Shot Humboldt
Operation Hardtack Phase II
Project 15.1

Both documents are now approved for public release.

Therefore, we are transmitting copies for inclusion into the DTIC system, if not found there.

Enclosure:
A/S

Arldith Jarrett
ARDITH JARRETT
Chief, Technical Support

DTIC QUALITY INSPECTED 4

FIREBALL CALCULATIONS
SHOT HUMBOLDT
OPERATION HARDTACK, PHASE II
PROJECT 15.1

Report No. B-2063
4 March 1960

Prepared by

J. E. Campbell
J. E. Campbell

Approved by

D. F. Seacord, Jr.
D. F. Seacord, Jr.

EDGERTON, GERMESHAUSEN & GRIER, INC.
Boston, Mass. Santa Barbara, Calif. Las Vegas, Nev.

FIREBALL CALCULATIONS - SHOT HUMBOLDT

1.0 INTRODUCTION

Shot Humboldt was a thirty-foot tower shot sponsored by LRL and detonated on 29 October 1958 in Area T-3V of the Nevada Test Site at 0645 FST.

The fireball yield was $3.3 \text{ tons} \pm 0.3 \text{ ton}$.

2.0 CAMERA INSTRUMENTATION AND OPERATION

Photographic coverage of fireball growth was provided by four high-speed Eastman cameras, two each at Station 3-357 (Transporter No. 3) and Station 3-358 (White Truck No. 2). Two Rapatronic cameras were located at each of these stations to record early fireball growth. In addition, a 15,000 frame-per-second EG&G Framing camera was used, located at Station 3-358 (6 x 6 No. 1). All cameras produced good records of this low-yield tower shot.

Station locations together with burst location are shown in Figure 1. Figure 2 is a summary of the survey data.

3.0 RESULTS

Application of phi-comparison (EG&G Report No. B-1869) indicates a yield of $3.3 \text{ tons} \pm 0.3 \text{ ton}$ for Shot Humboldt.

An air density of 1.097 grams per liter was used in the yield calculations, based on a pressure of 885 millibars, a temperature of 7.4°C , and a relative humidity of 46% at the height of the device at shot time.

The following table shows the comparison shots and the Humboldt yield obtained by the phi-comparison.

Comparison Shot	Humboldt Yield (Tons)
<u>Air Drop</u>	
Osage	3.35
Ranger A	3.17
Buster B	3.20
Wasp	3.41
Wasp [†]	3.41
Ranger E	3.25
<u>Balloon</u>	
Rushmore	3.51
Hidalgo	3.36
Lea	3.46
<u>Tower</u>	
Post	3.26
UK-3	3.25
Chaves	3.53
Hornet	3.33
Moth	3.19
Quay	3.24
$\bar{W} = 3.3 \text{ tons}$	

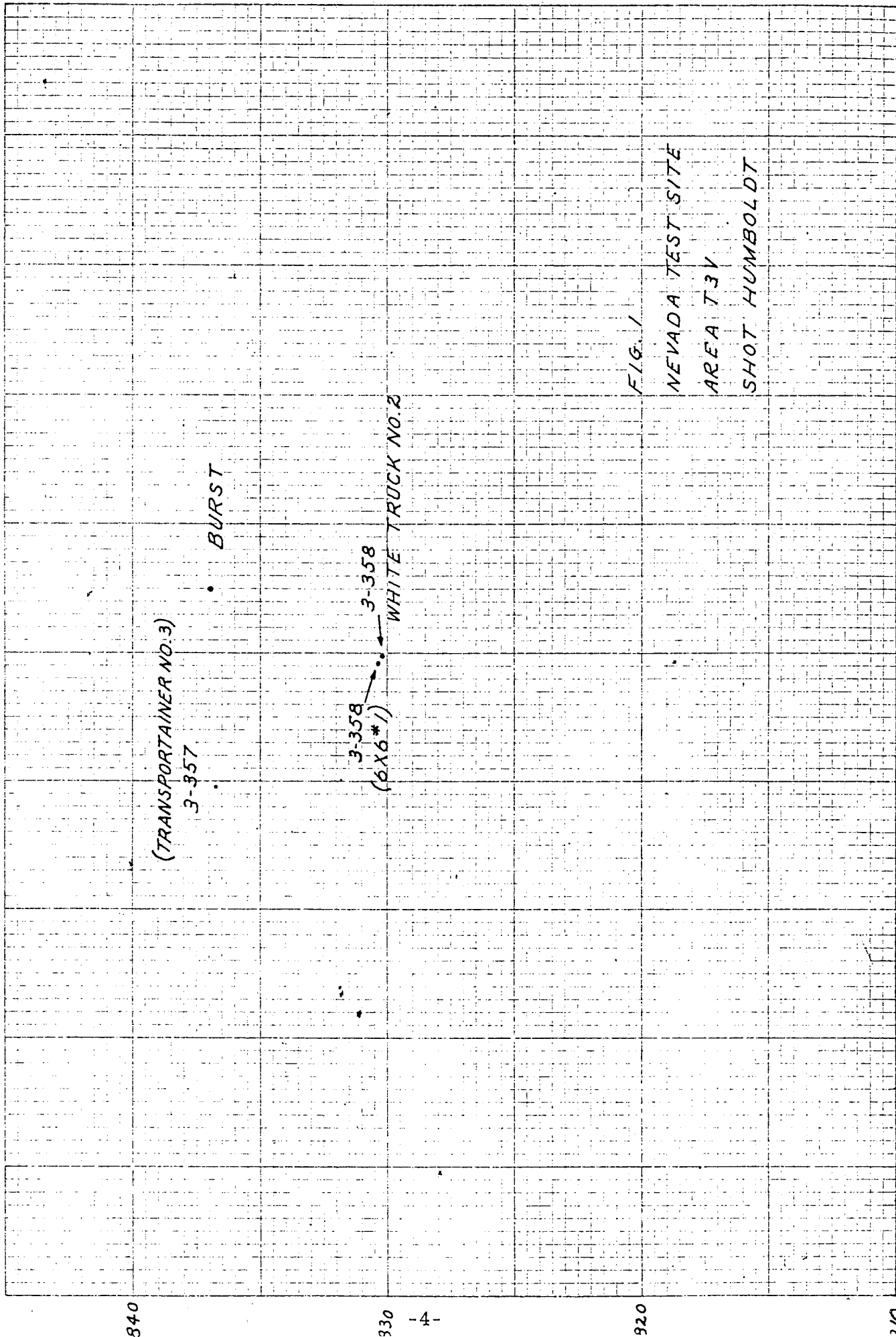
Diameter vs time and phi vs time plots are shown in Figs. 3 and 4.

The following data sheets are included for each film:

- Photo Plan and Photo Loading Chart
- Camera Data and Calculation Sheet
- Diameter Measurement Sheet
- E-102 Print-Out Sheet of D, t, and ϕ

The zero-frame times of the Eastman and Framing camera records were determined by comparison with the Rapatronic diameter-time data.

Appendix A contains photographic examples of the Humboldt fireball.



HUMBOLDT

SURVEY DATA

GZ STA. 73V

[illegible]

FORM E17(1-55 500)

NAME ANALYSIS

EDGERTON, GERMESHAUSEN & GRIER INC.

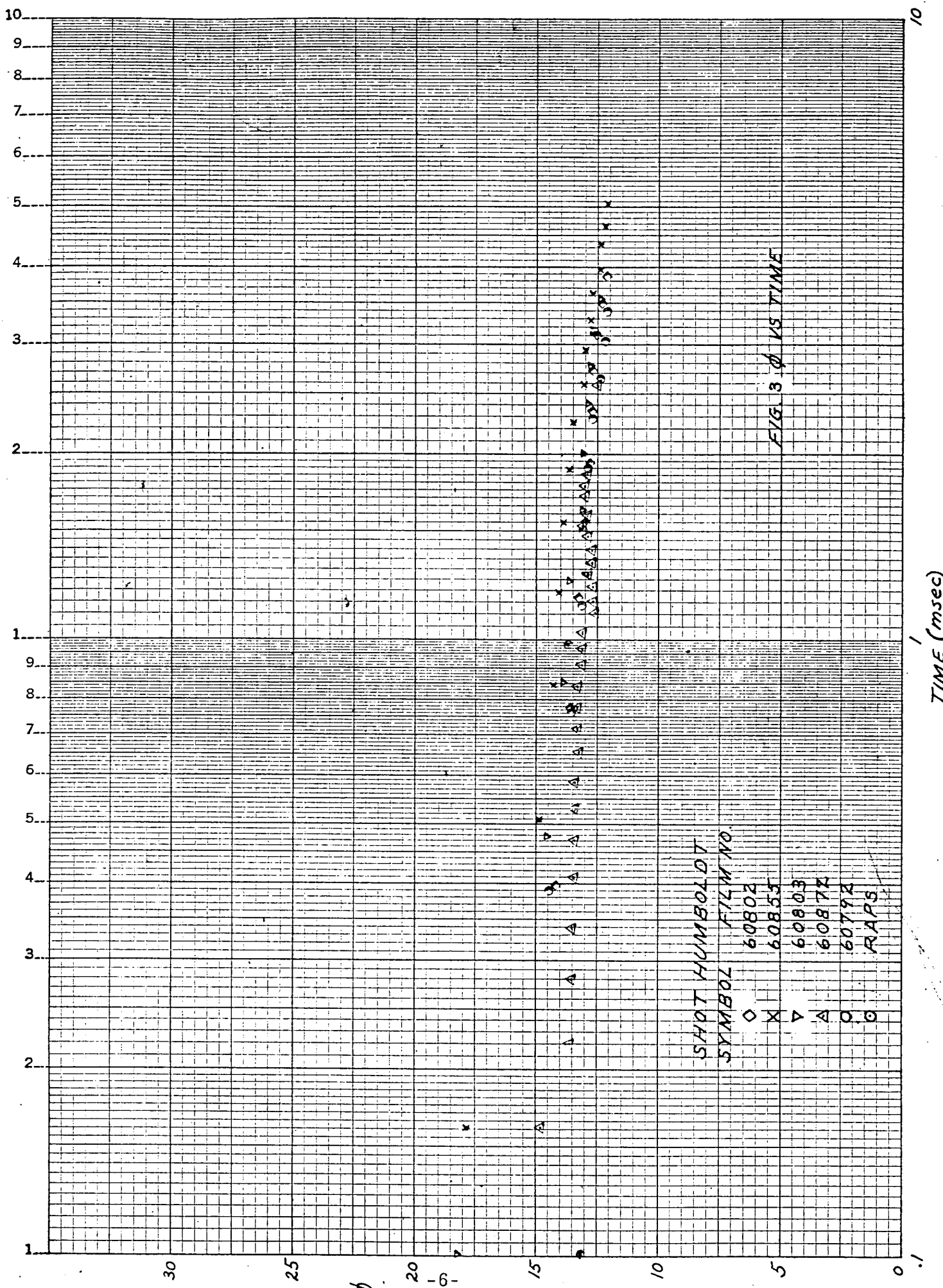


FIG 3 ϕ VS TIME

TIME (msec)

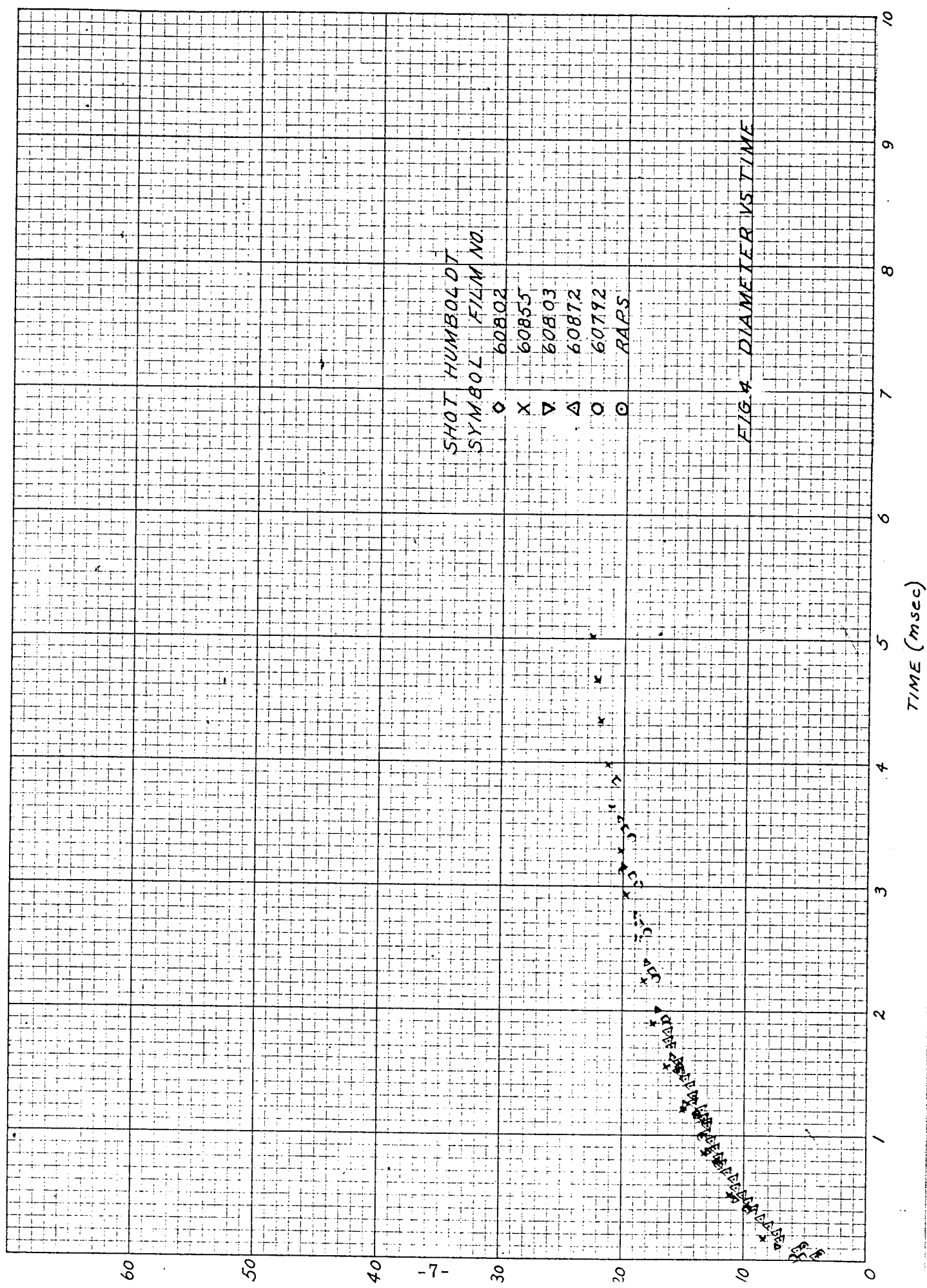


Table I

Hardtack Phase II, Humboldt
Fireball Camera Distribution

Station	Camera	Qualitative Functioning
3-357 Transportainer No. 3	E-33	Record
	E-1	Record
	R-34	Record
	R-30	Record
3-358 White Truck No. 2	E-11	Record
	E-5	Record
	XR-3	Record
	R-4	Record
3-358 6 x 6 No. 1	Framing	Record

Table II

Hardtack Phase II, Humboldt
Average Diameter vs Time

Time (m sec)	Diameter (meters)
0.5	10.5
1.0	13.5
1.5	15.5
2.0	17.0
2.5	18.5
3.0	19.5
3.5	20.0
4.0	21.0

Table III
Hardtack Phase II, Humboldt

Rapatronic Summary

Station	Film No.	Camera No.	Horizontal Range (m)	F. L. (mm)	Diameter (m)	Time (ms)
3-357	60851	R-34	2339.3	479.03	13.67	0.99
	60852	R-30	2339.3	479.30	3.75	0.05
3-358	60794	XR-3	2163.9	476.76	5.21	0.10
	60795	R-4	2163.9	477.82	20.17	3.15

PHOTO LOADING CHART

STATION 3-358 6x6 #1

EVENT HUMBOLDT

DATE 10/29/58[illegible][illegible]

REMARKS _____

FINAL

TATION NO. 3-358

TATION TYPE	<u>WHITE TRUCK No. 2</u>
-------------	--------------------------

DISTANCE GZ 7099.4 ft

1) DISTANCE: OBJECT 7100.0 ft

PHOTO PLAN

BRG 21° 03'

STATION	TYPE	WHITE	BLACK	NO. 2
1				
2				
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99				
100				

N 830 358

F 684 829

3997

GZ

836 984

687 378

4054

DIFF.

6626

2549

57

Tilt

GZ 0° 13'

OBJ 0° 28'

EVENT HUMBOLDT

GZ STA. T 3 V

DATE 10/29/58

POSTED 10/31/58

PHOTO PLAN

CAMERA			LENS			FIELD TARGET H/V	AIMING			POWER			MARKER		DELAY AS	FILM	PUR- POSE	REMARKS
NO.	NOM SPD.	RACK POS.	FOC. MM	S/N	FILTER		OBJECT	H	V	VOLTS	SHUT RHEO.	TIME ON/OFF	TYPE	S/N				
E-11	2500	C-1	30.5	784691	ND-1	F.B	0°00'	0°29'	120 DC	40%	-1.5/ +1.5	200	60	=	MF	15.1		
E-5	2500	C-2	25.4	876312	W-12	F.B	0°00'	0°45'	120 DC	40%	-1.5/ +1.5	200	10	=	MF	15.1		
XR-3	445 COIL	A-1	4.80	774695	ND-1	F.B	0°00'	0°6'	115 AC 24 DC	BULB	=	FM	5	100	RP	15.1	100 μ sec delay	
R-4	4045 COIL	A-2	4.80	773952	=	F.B	0°00'	0°09'	115 AC 24 DC	BULB	=	FM	5	3000	RP	15.1	3000 μ sec delay	
30 SP	64	C-3	18.5	11026	=	DOC.	0°00'	8°29'	24 DC	133°	-5/ +30	=	=	=	D KDC	15.1		
110 SP	64	C-3	18.5	12297	=	DOC.	0°00'	8°30'	24 DC	133°	-5/ +30	=	=	=	D KDC	15.1		
						ACTUAL RAP DELAYS												
						XR-3	97.4 μ sec	2 μ sec	20 μ sec	20 μ sec	half coil delay							
						R-4	3127.6 μ sec	20 μ sec	20 μ sec	20 μ sec	half coil delay							

	REMARKS
*	* INCLUDES 30 FT., HEIGHT OF TOWER

78N17

As a result of the above, the following is proposed:

EDGERTON, GERMESHAUSEN & CO., INC.

PHOTO LOADING CHART

STATION 3-358 WHITE TRUCK No. 2 EVENT HUMBOLDT DATE 10/29/58

DATE 10/29/58

[illegible]

DATE FILM LOADED-

DATE CAMERA LOADED

DATE EXPOSED _____

REMARKS

FINAL

FORM E-40

EDGERTON, GERMESHAUSEN & GRIER, INC.

STATION NO. 3-357STATION TYPE TRANSPORTER No. 3DISTANCE GZ 7675.1 ftDISTANCE OBJECT 7675.3 ft

STATION

N 836 766E 679 706Z 4 046

GZ

836 984687 3784 054 *

DIFF.

21876728

PHOTO PLAN

BRG 88° 22'

TILT

GZ -0° 10'OBJ 0° 4'EVENT HUMBOLDTGZ STA. 73VDATE 10/29/58POSTED 10/31/58

CAMERA		LENS		FIELD TARGET H/V	AIMING		POWER		MARKER		DELAY MS	FILM	PUR- POSE	REMARKS
NO.	NOM SPD.	RACK POS.	FOC. MM	S/N	FILTER	OBJECT	H	V	VOLTS	SHUT RHEO.	TIME ON/OFF	TYPE	S/N	
E-33	2500	B-2	305	784702	ND-1	F.B.	0°00'	0°27'	120DC	40/80	-1.5/ +1.5	MF	4	15.1
E-1	2500	B-1	500	C73377	W-12	F.B.	0°00'	0°4'	120DC	40/80	-1.5/ +1.5	MF	2	15.1
M-2	100	A-1	50	MA4481	W-12	CLOUD	0°00'	7°48'	120DC	170°	-5/ +30	FX	4	15.1
R-34	400	A-2	480	773948	=	F.B.	0°00'	0°27'	115AC 24DC	BULB	=	RP	11	15.1 1000 μsec delay
R-30	400	A-3	480	773953	ND-1	F.B.	0°00'	0°27'	115AC 24DC	BULB	=	RP	11	15.1 50 μsec delay
60	64	A-1	25	69261	=	DOC.	0°00'	7°58'	24DC	133°	-5/ +30	D KDC	=	15.1
128	64	A-1	18.5	12318	=	DOC.	0°00'	0°24'	24DC	133°	-5/ +30	D KDC	=	15.1
ACTUAL RAP DELAYS														
						R-34	968.4	μsec +	20 μsec	half coil delay				
						R-30	53.9	μsec +	2 μsec	half coil delay				

REMARKS * INCLUDES 30 ft HEIGHT OF TOWER

FINAL

PHOTO LOADING CHART

STATION 3-357 TRANSPORTAINER No.3 **EVENT** HUMBOLDT

DATE 10/29/58[illegible]

DATE FILM LOADED _____

DATE CAMERA LOADED

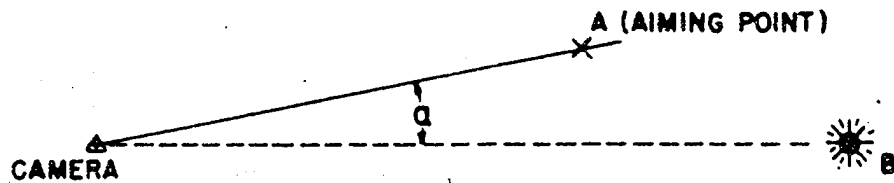
DATE EXPOSED

REMARKS

FINAL

CAMERA DATA & CALCULATIONS

FILM NO. 60794	STATION NO. ^{WHITE TRUCK NO. 2} 3-35B	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. XR-3	EQ. AP.		DATE: 12/1/58



HORIZONTAL
PROJECTION

A. $R^{\circ}A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 0^{\circ} 45'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.999914$	$H_C = 3997 \text{ ft}$
$CB_h = 2163.9 \text{ m}$	$\sin \beta = 0.013090$	$\Delta H = 57 \text{ ft} = 17.4 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2163.7 \text{ m}$	$\Delta H \sin \beta = 0.23 \text{ m}$	$R^{\circ}A = \boxed{2163.93 \text{ m}}$

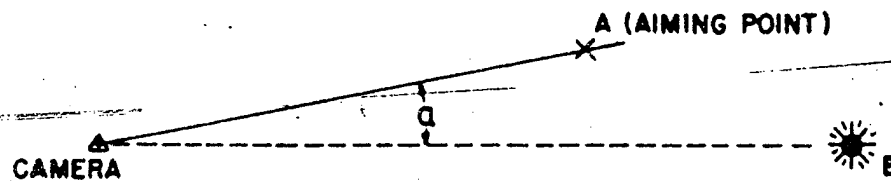
B. FOCAL LENGTH 476.76 mm (774695)

C. MAGNIFICATION FACTOR (meters/in.) 115.29

D. ZERO TIME CORRECTION 0.10 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60795	STATION NO. ^{WHITE TRUCK NO. 2} 3-358	TEST HUMBOLDT	CALCULATED BY: JE.
CAMERA NO. R-4	EQ. AP.		DATE: 12/1/58



**HORIZONTAL
PROJECTION**

A. $R^{\circ}A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 0^{\circ} 45'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.999914$	$H_C = 3997 \text{ ft}$
$CB_h = 2163.9 \text{ m}$	$\sin \beta = 0.013090$	$\Delta H = 57 \text{ ft} = 17.4 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2163.7 \text{ m}$	$\Delta H \sin \beta = 0.23 \text{ m}$	$R^{\circ}A = \boxed{2163.93 \text{ m}}$

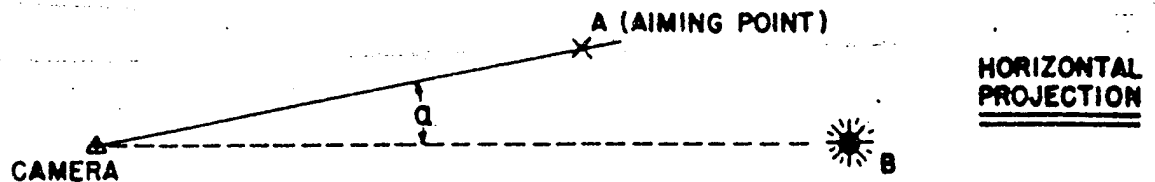
B. FOCAL LENGTH 477.82 mm (773952)

C. MAGNIFICATION FACTOR (meters/in.) 115.03

D. ZERO TIME CORRECTION 3.15 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60851	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. R-34	EQ. AP.		DATE: 12/1/58



A. $R^{\circ}_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 0^{\circ} 27'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.99997$	$H_C = 4046 \text{ ft}$
$CB_h = 2339.4 \text{ m}$	$\sin \beta = 0.00785$	$\Delta H = 8 \text{ ft} = 2.44 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2339.3 \text{ m}$	$\Delta H \sin \beta = 0.00 \text{ m}$	$R^{\circ}_A = \boxed{2339.3 \text{ m}}$

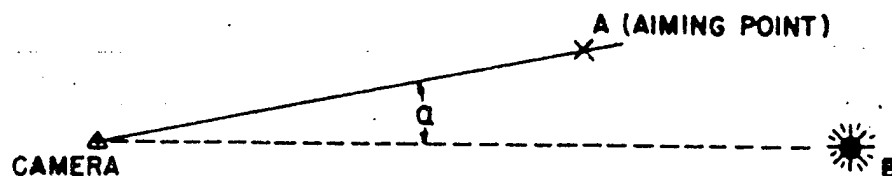
B. FOCAL LENGTH 479.03 mm (773948)

C. MAGNIFICATION FACTOR (meters/in.) 124.04

D. ZERO TIME CORRECTION 0.99 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60852	STATION NO. 3-357 <small>TRANSDRAINER No. 3</small>	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. R-30	EQ. AP.		DATE: 12/1/58



HORIZONTAL
PROJECTION

A. $R^0/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 0^\circ 27'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.99997$	$H_C = 4046 \text{ ft}$
$CB_h = 2339.4 \text{ m}$	$\sin \beta = 0.00785$	$\Delta H = 8 \text{ ft} = 2.44 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2339.3 \text{ m}$	$\Delta H \sin \beta = 0.00 \text{ m}$	$R^0/A = \boxed{2339.3 \text{ m}}$

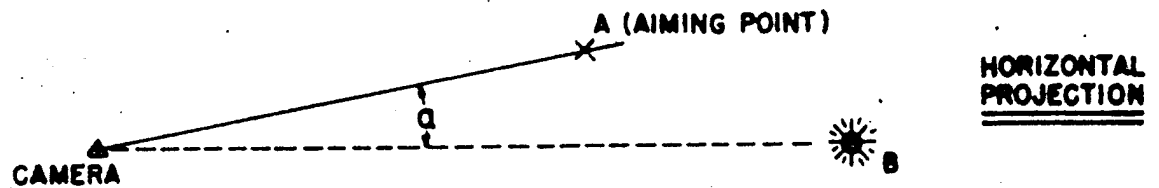
B. FOCAL LENGTH 479.30 mm (773953)

C. MAGNIFICATION FACTOR (meters/in.) 123.97

D. ZERO TIME CORRECTION 0.05 msec delay

CAMERA DATA & CALCULATIONS

FILM NO. 60855	STATION NO. <small>WHITE TRUCK NO. 2</small> 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.		DATE: 10/29/58



A. $R\%_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = 0^\circ 45'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.999914$	$H_C = 3997 \text{ ft}$
$CB_h = 2163.9 \text{ m}$	$\sin \beta = 0.013090$	$\Delta H = 57 \text{ ft} = 17.4 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2163.7 \text{ m}$	$\Delta H \sin \beta = 0.23 \text{ m}$	$R\%_A = \boxed{2163.93 \text{ m}}$

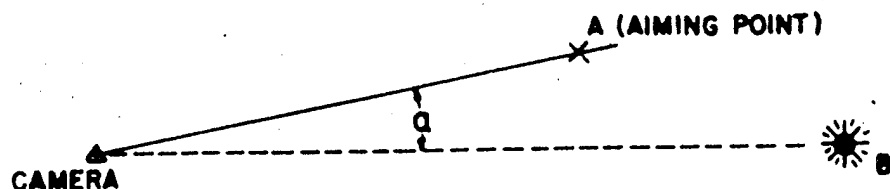
B. FOCAL LENGTH 250.2 mm (876312)

C. MAGNIFICATION FACTOR (meters/in.) 219.68

D. ZERO TIME CORRECTION 0.16 msec

CAMERA DATA & CALCULATIONS

FILM NO. 60855	STATION NO. <small>WHITE TRUCK NO. 2</small> 3-358	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-5	EQ. AP.		DATE: 10/29/58



**HORIZONTAL
PROJECTION**

A. $R\%_A = CB_h \cos a \cos \beta + (H_B - H_C) \sin \beta$

$a = 0^\circ 00'$	$\beta = 0^\circ 45'$	$H_B = 4054 \text{ ft}$
$\cos a = 1.00000$	$\cos \beta = 0.999914$	$H_C = 3997 \text{ ft}$
$CB_h = 2163.9 \text{ m}$	$\sin \beta = 0.013090$	$\Delta H = 57 \text{ ft} = 17.4 \text{ m}$
$CB_h \cos a \cos \beta = 2163.7 \text{ m}$	$\Delta H \sin \beta = 0.23 \text{ m}$	$R\%_A = \boxed{2163.93 \text{ m}}$

B. FOCAL LENGTH 250.2 mm (876312)

C. MAGNIFICATION FACTOR (meters/in.) 219.68

D. ZERO TIME CORRECTION 0.16 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT

FILM NO. 60855

[illegible]

READ BY GGO JEC TYPED BY

DATE	10/29/58	DATE
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REMARKS:

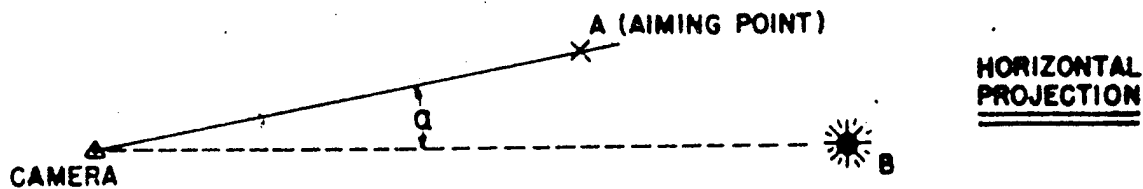
FIREBALL CALCULATIONS

SHOT HUMBOLDT FILM NO. 60855
DATE _____

D	t	ln D	Int	$t^{2/5}$	ϕ
8.53	.15	2.14766	1.83250 -	.480463	177.53
11.99	.51	2.42384	.67335 -	.763882	147.79
13.38	.85	2.59377	16245 -	.937085	142.78
15.05	1.20	2.71145	18225	10.75626	139.91
16.49	1.55	2.80283	43833	11.91642	138.38
17.55	1.90	2.86511	64187	12.92721	135.76
18.50	2.25	2.91780	81086	13.83128	133.75
19.03	2.59	2.94604	95158	14.63210	130.05
19.86	2.94	2.98870	107837	15.39733	129.01
20.43	3.29	3.01699	119090	16.10207	126.87
21.07	3.64	3.04782	129204	16.76684	125.66
21.45	3.99	3.06568	138386	17.39412	123.31
22.06	4.35	3.09371	147024	18.00558	122.51
22.51	4.68	3.11390	154733	18.53981	121.41
22.95	5.03	3.12829	161542	19.08217	119.74

CAMERA DATA & CALCULATIONS

FILM NO. 60802	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-33	EQ. AP.		DATE: 12/1/58



A. $R^{\circ}/A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^{\circ} 00'$	$\beta = 0^{\circ} 27'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 0.99997$	$H_C = 4046 \text{ ft}$
$CB_h = 2339.4 \text{ m}$	$\sin \beta = 0.00785$	$\Delta H = 8 \text{ ft} = 2.44 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2339.3 \text{ m}$	$\Delta H \sin \beta = 0.00 \text{ m}$	$R^{\circ}/A = \boxed{2339.3 \text{ m}}$

B. FOCAL LENGTH 306.9 mm (784702)

C. MAGNIFICATION FACTOR (meters/in.) 193.6

D. ZERO TIME CORRECTION 0.01 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT

FILM NO. 60802

[illegible]

READ BY LW JEC TYPED BY

DATE	10/29/58	DATE
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REMARKS:

FIREBALL CALCULATIONS

SHOT HUMBOLDT

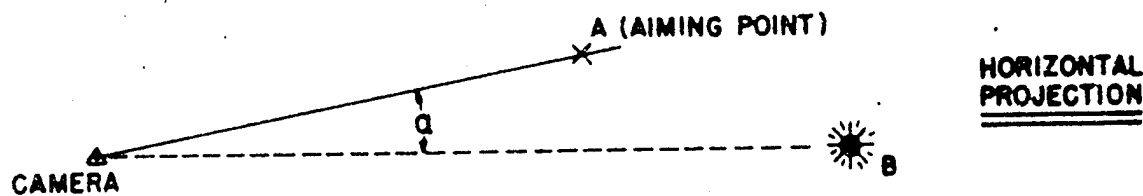
FILM NO. 60802

DATE _____

D	t	ln D	Int	$t^{2/5}$	ϕ
5.23	.01	1.65439	4.60509	.159064	328.79
9.79	.40	2.28133	9.1621	.693164	141.23
12.30	.78	2.50955	248.44	.905399	135.85
14.04	1.17	2.64195	156.93	10.64784	131.85
15.38	1.55	2.73314	438.33	11.91642	129.06
16.55	1.94	2.80646	662.69	13.03533	126.96
17.69	2.33	2.87305	845.79	14.02588	126.12
18.75	2.71	2.93175	996.88	14.89965	125.90
19.50	3.10	2.97042	1131.39	15.72327	124.01
20.13	3.48	3.00220	1247.07	16.46795	122.23
20.60	3.87	3.02527	1353.32	17.18293	119.88

CAMERA DATA & CALCULATIONS

FILM NO. 60803	STATION NO. 3-357	TEST HUMBOLDT	CALCULATED BY: JEC
CAMERA NO. E-1	EQ. AP.		DATE: 12/1/58



A. $R^0_A = CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$

$\alpha = 0^\circ 00'$	$\beta = -0^\circ 4'$	$H_B = 4054 \text{ ft}$
$\cos \alpha = 1.00000$	$\cos \beta = 1.00000$	$H_C = 4046 \text{ ft}$
$CB_h = 2339.4 \text{ m}$	$\sin \beta = 0.00116$	$\Delta H = 8 \text{ ft} = 2.44 \text{ m}$
$CB_h \cos \alpha \cos \beta = 2339.4 \text{ m}$	$\Delta H \sin \beta = 0.00 \text{ m}$	$R^0_A = \boxed{2339.4 \text{ m}}$

B. FOCAL LENGTH 541.6 mm (C73377)

C. MAGNIFICATION FACTOR (meters/in.) 109.7

D. ZERO TIME CORRECTION 0.10 msec

DIAMETER MEASUREMENTS

SHOT HUMBOLDT

FILM NO. 60803

[illegible]

READ BY plw rh

TYPED BY

DATE _____

~~CONFIDENTIAL~~ 10/29/58

DATE _____

REMARKS:

FIREBALL CALCULATIONS

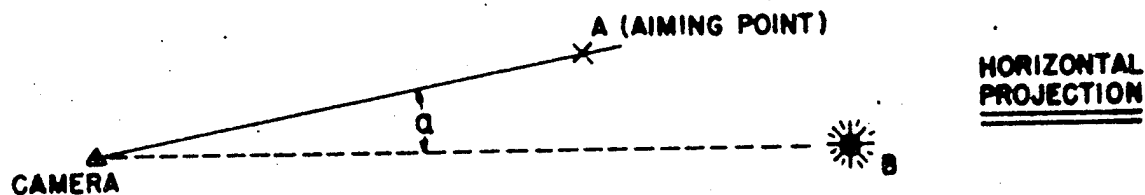
SHOT HUMBOLDT FILM NO. 6 0803

DATE _____

D	t	ln D	Int	$t^{2/5}$	ϕ
7.26	.10	1.98234	2.30251 -	.308119	18235
1079	.48	2.37856	73394 -	745590	14471
1305	.86	2.56878	15075 -	941480	13861
1485	1.25	2.69807	22310	1093345	13582
1596	1.63	2.77016	48865	1215873	13126
1716	2.01	2.84265	69812	1322137	12978
1823	2.40	2.90311	87539	1419290	12844
1908	2.78	2.94866	102239	1505247	12675
2005	3.17	2.99822	115373	1586440	12638
2050	3.55	3.02040	126700	1659971	12349

CAMERA DATA & CALCULATIONS

50792	STATION NO. ^{WHITE TRUCK NO. 2} 3-358	TEST <i>HUMBOLDT</i>	CALCULATED BY: <i>JEC</i>
<i>E-11</i>	EQ. AP.		DATE: <i>12/1/58</i>



$$= CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$$

	$\beta = 0^\circ 29'$	$H_B = 4054 \text{ ft}$
<i>00000</i>	$\cos \beta = 0.99996$	$H_C = 3997 \text{ ft}$
<i>53.9 m</i>	$\sin \beta = 0.00844$	$\Delta H = 57 \text{ ft} = 17.37 \text{ m}$
$\cos \beta = 2163.8 \text{ m}$	$\Delta H \sin \beta = 0.1 \text{ m}$	$R^0/A = \boxed{2163.9 \text{ m}}$

AL LENGTH *305.9 mm (784691)*

MAGNIFICATION FACTOR (meters/in.) *179.68*

TIME CORRECTION *0.01 msec*

DIAMETER MEASUREMENTS

SHOT HUMBOLDT

FILM NO. 60792

[illegible]

READ BY plw jc rh TYPED BY

DATE 10/29/58

REMARKS :

FIREBALL CALCULATIONS

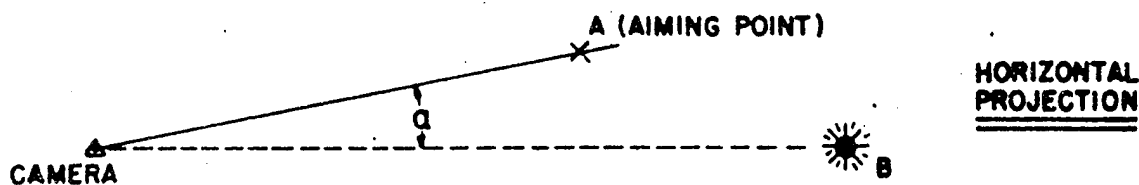
SHOT HUMBOLDT FILM NO. 60792

DATE _____

b	t	ln D	Int	$t^{2/3}$	ϕ
6.00	.01	1.79168	4.60509 -	.159064	37.720
9.86	39	2.28844	941.53 -	6.86180	143.69
12.23	76	2.50384	274.44 -	8.96034	136.49
13.85	114	2.62832	130.95	10.53776	131.43
15.32	151	2.72923	412.18	11.79242	129.91
16.50	189	2.80343	636.59	12.89997	127.90
17.42	227	2.85768	819.71	13.88031	125.50
18.16	264	2.89926	970.70	14.74446	123.16
18.90	302	2.93918	1105.23	15.55961	121.46
19.57	340	2.97400	1223.81	16.31539	119.94

CAMERA DATA & CALCULATIONS

0872	STATION NO. ³⁻³⁵⁸ (6x6 #1)	TEST <i>HUMBOLDT</i>	CALCULATED BY: <i>JEC</i>
FRAMING	EQ. AP.		DATE: <i>1/29/60</i>



$$CB_h \cos \alpha \cos \beta + (H_B - H_C) \sin \beta$$

0'	$\beta = 0^\circ 29'$	$H_B = 4054 \text{ ft}$
10000	$\cos \beta = 0.99996$	$H_C = 3997 \text{ ft}$
4.7 m	$\sin \beta = 0.00844$	$\Delta H = 57 \text{ ft} = 17.37 \text{ m}$
$\cos \beta = 2164.6 \text{ m}$	$\Delta H \sin \beta = 0.1 \text{ m}$	$R^0/A = \boxed{2164.7 \text{ m}}$

L LENGTH

IFICATION FACTOR (meters/in.)

TIME CORRECTION *0.03 msec 1/2 fr*

DIAMETER MEASUREMENTS

SHOT HUMBOLDT

FILM NO. 60872

[illegible]

READ BY JEC RCS

TYPED BY

DATE 1/29/60

DATE _____

REMARKS:

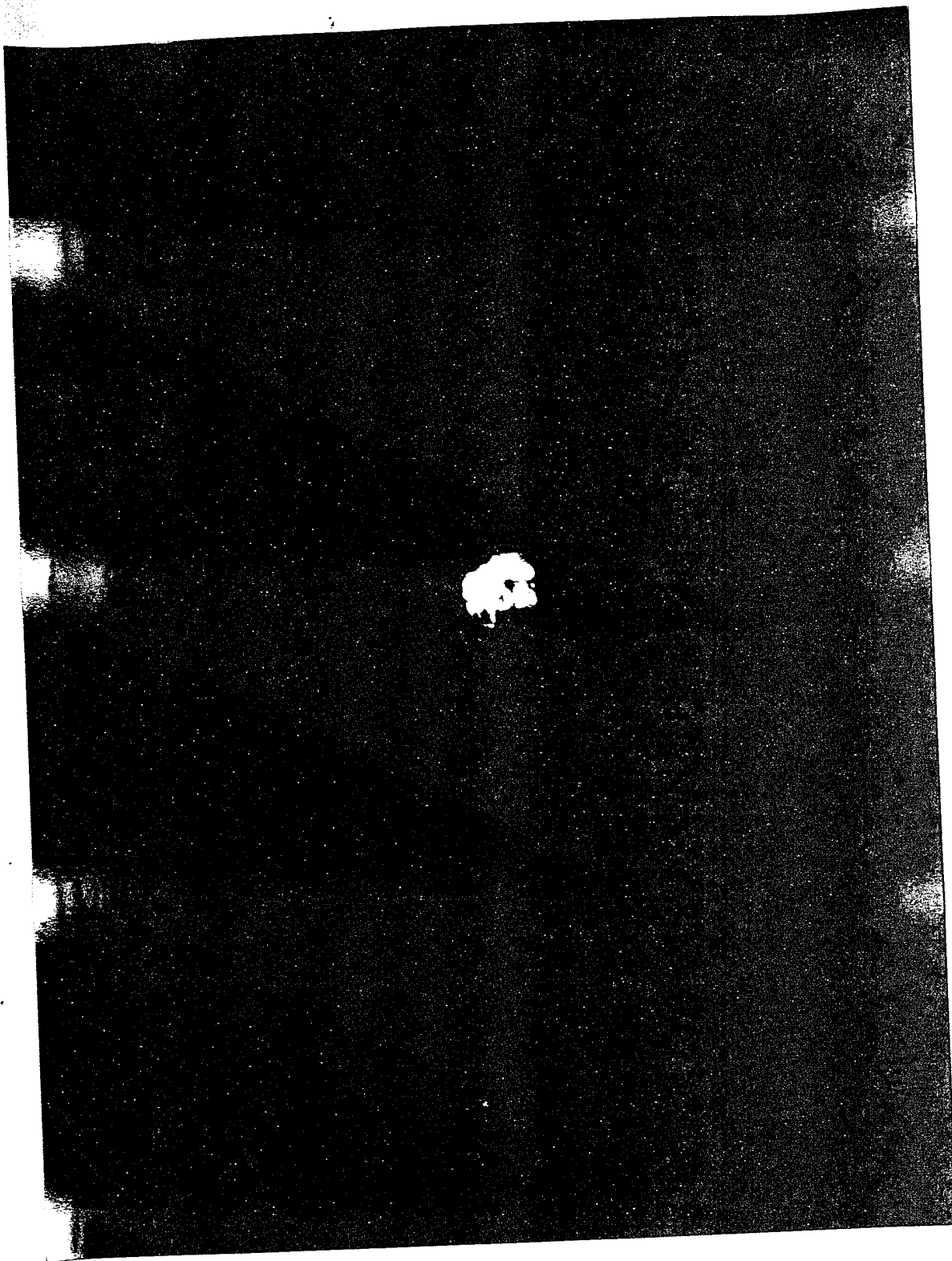
FIREBALL CALCULATIONS

SHOT HUMBOLDT FILM NO. 60872

DATE _____

D	t	ln D	Int	$t^{2/5}$	ϕ
4.16	.03	1.42559	3.50658 -	2.45999	16910
5.72	.09	1.74390	2.40787 -	3.81691	14985
7.13	.16	1.96427	1.83250 -	4.80463	14839
7.46	.22	2.00954	1.51418 -	5.45706	13670
8.14	.28	2.09683	1.27302 -	6.00969	13544
8.80	.34	2.17482	1.07877 -	6.49526	13548
9.41	.41	2.24181	.89152 -	7.00045	13441
9.91	.47	2.29349	.75498 -	7.39341	13403
10.39	.53	2.34083	.63490 -	7.75720	13393
10.85	.59	2.38410	.52770 -	8.09707	13399
11.19	.66	2.41404	.41559 -	8.46845	13213
11.73	.72	2.46208	.32854 -	8.76851	13377
12.14	.78	2.49645	.24844 -	9.05399	13408
12.37	.84	2.51523	.17429 -	9.32657	13263
12.66	.91	2.53842	.9424 -	9.63003	13146
12.98	.97	2.56340	.3046 -	9.87886	13139
13.35	1.03	2.59153	.2956	10.11896	13193
13.10	1.10	2.57261	.9524	10.38831	12610
13.55	1.16	2.60641	1.4834	10.61133	12769
13.77	1.22	2.62252	1.9879	10.82766	12717
14.38	1.28	2.66589	2.4683	11.03774	13028
14.33	1.34	2.66241	2.9268	11.24200	12746
14.74	1.41	2.69063	3.4363	11.47348	12847
15.11	1.47	2.71543	3.8532	11.66642	12951
15.60	1.53	2.74735	4.2534	11.85466	13159
15.55	1.60	2.74414	4.7008	12.06872	12884
16.24	1.72	2.78755	5.4238	12.42288	13072
16.48	1.78	2.80222	5.7666	12.59438	13085
16.53	1.85	2.80525	6.1521	12.79011	12924

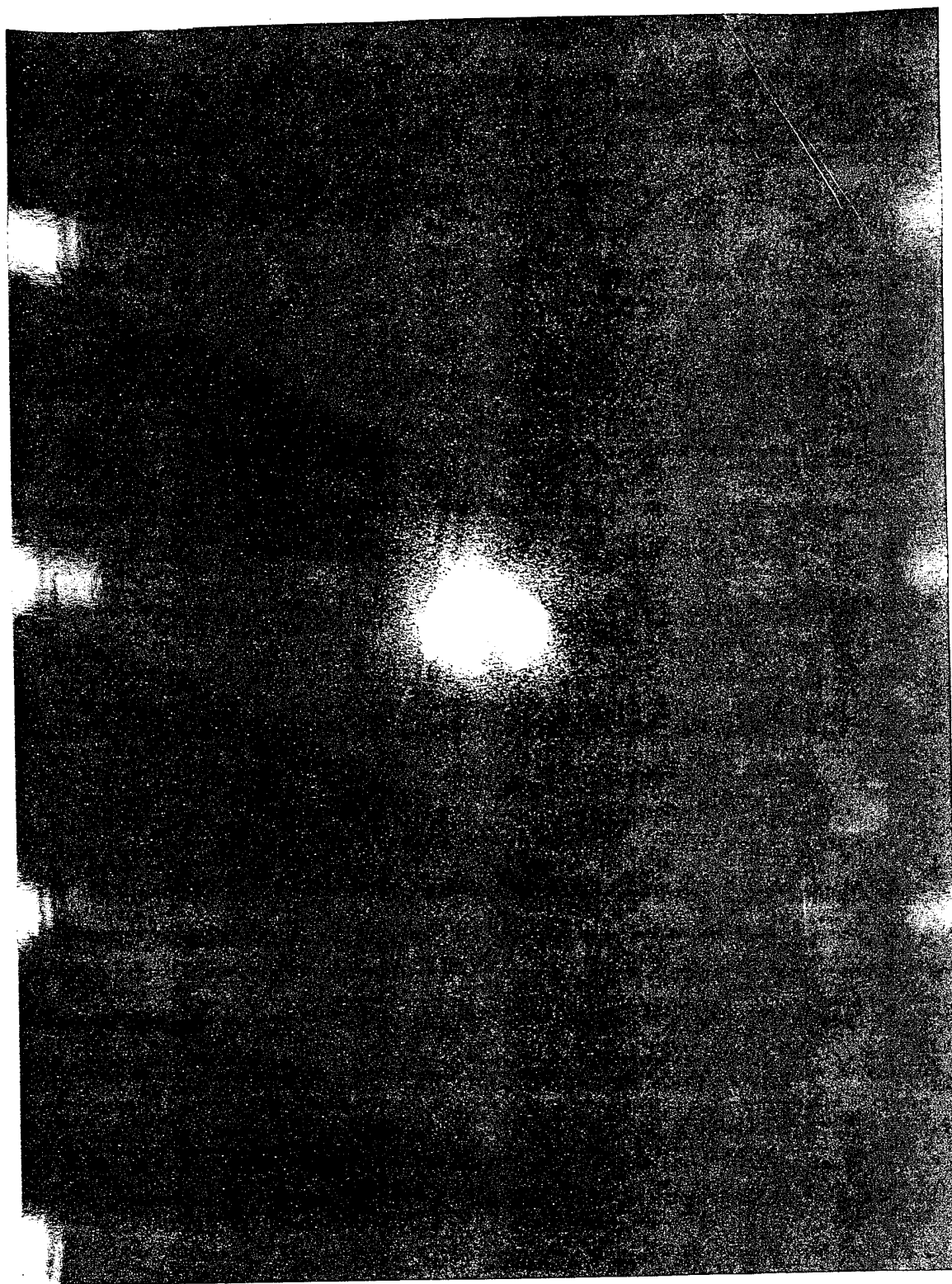
APPENDIX A
HARDTACK PHASE II, HUMBOLDT
PHOTOGRAPHIC EXAMPLES



Camera: Rapatronic-30

Station: 3-357

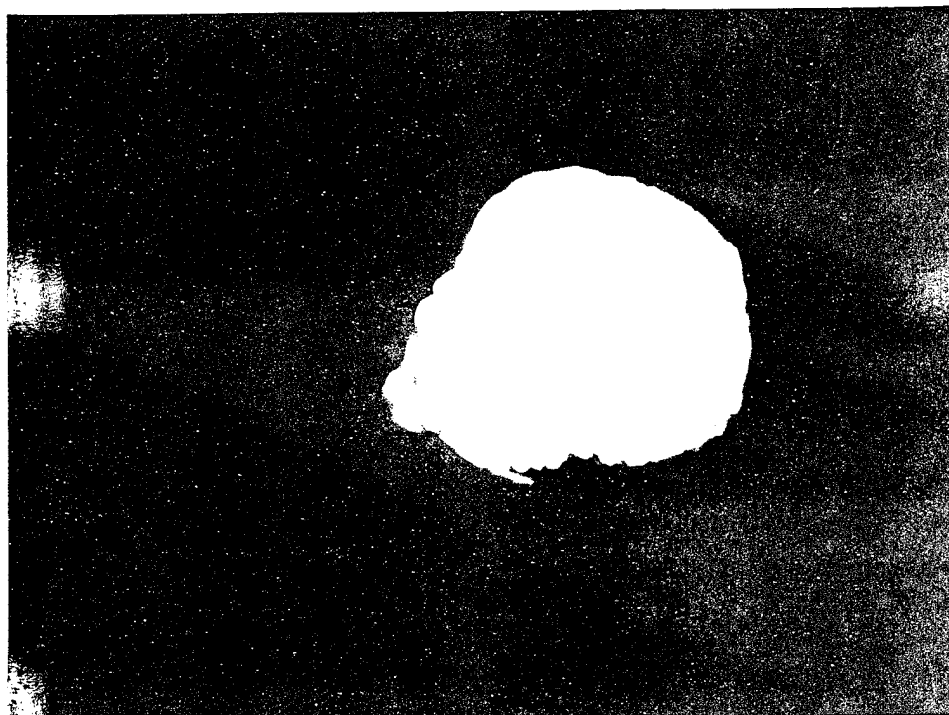
Time: 0.05 msec



Camera: XR-3

Station: 3-358

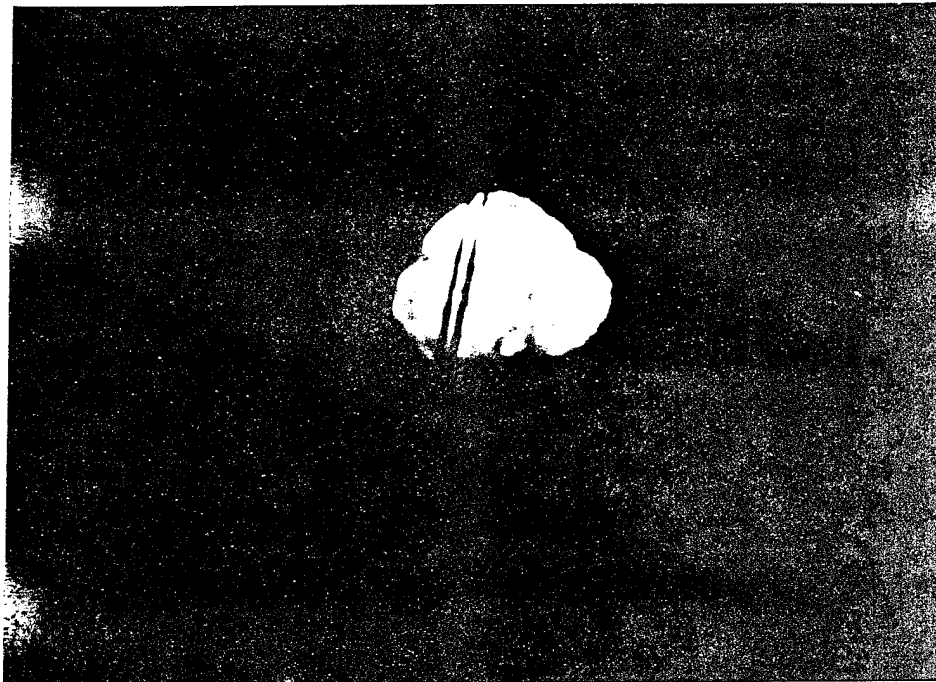
Time: 0.10 msec



Camera: E-1

Station: 3-357

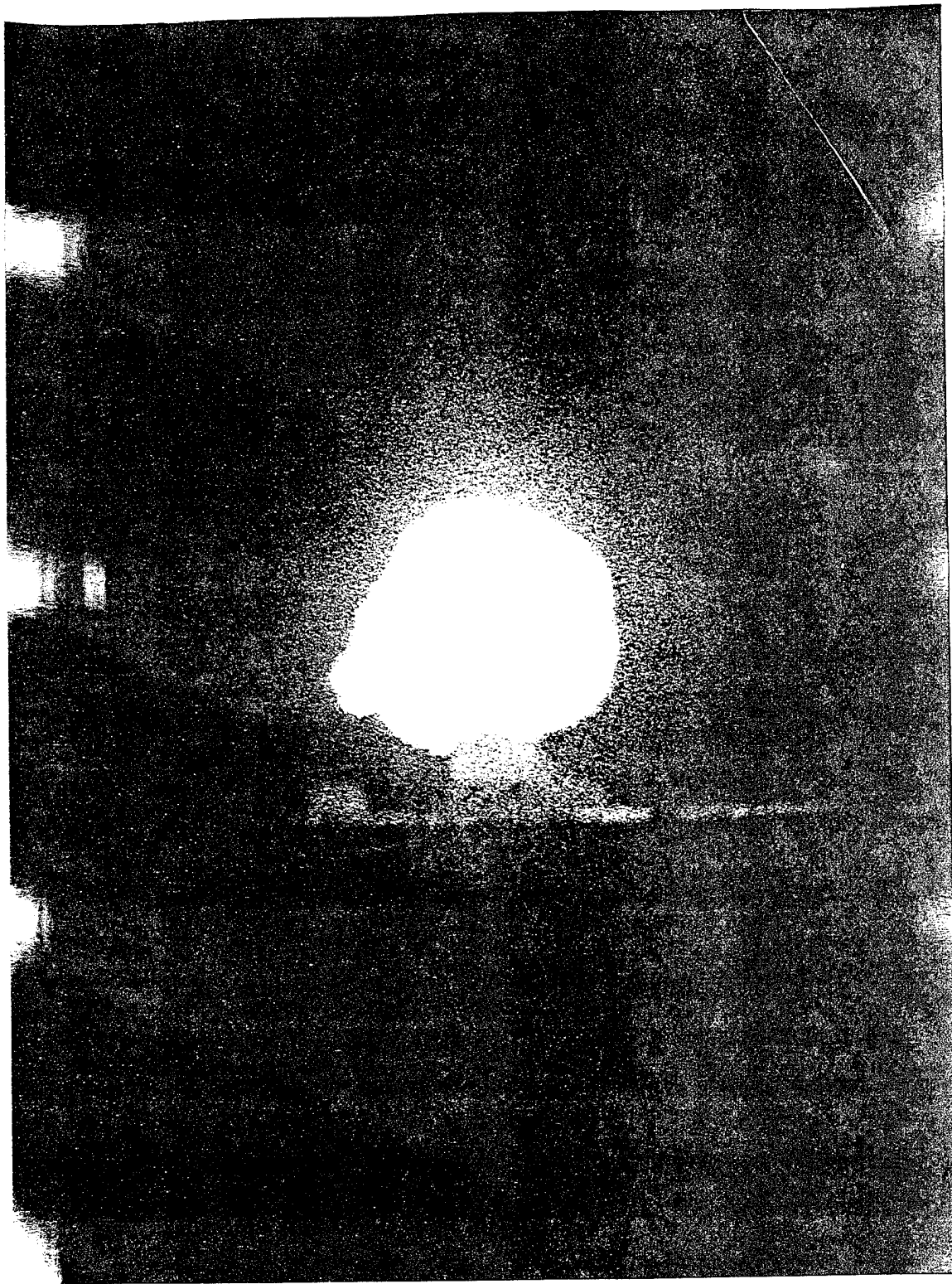
Time: 0.48



Camera: E-11

Station: 3-358 (White Truck No. 2)

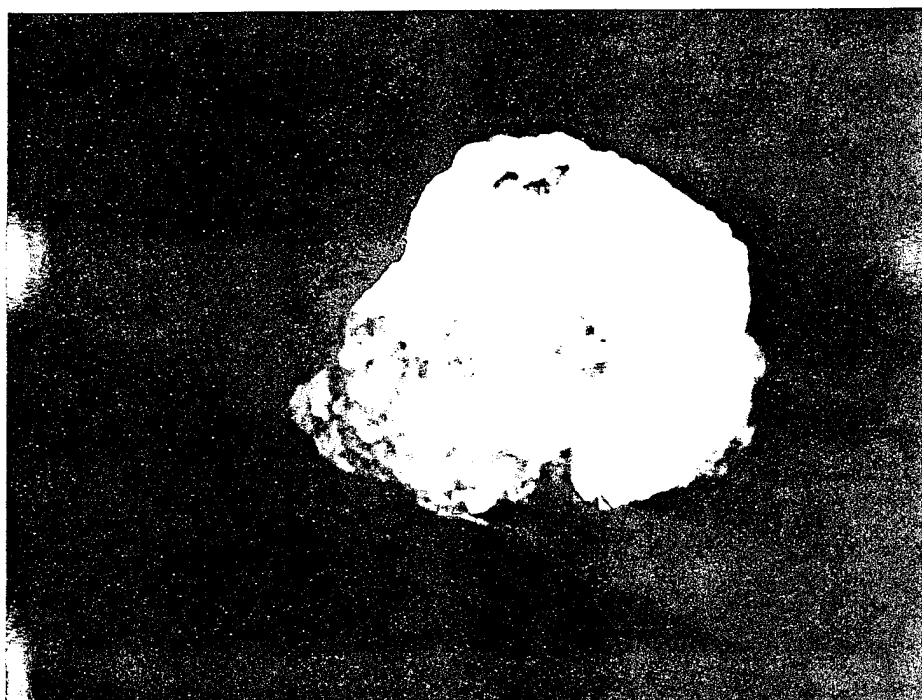
Time: 0.76 msec



Camera: Rapatronic R-34

Station: 3-357

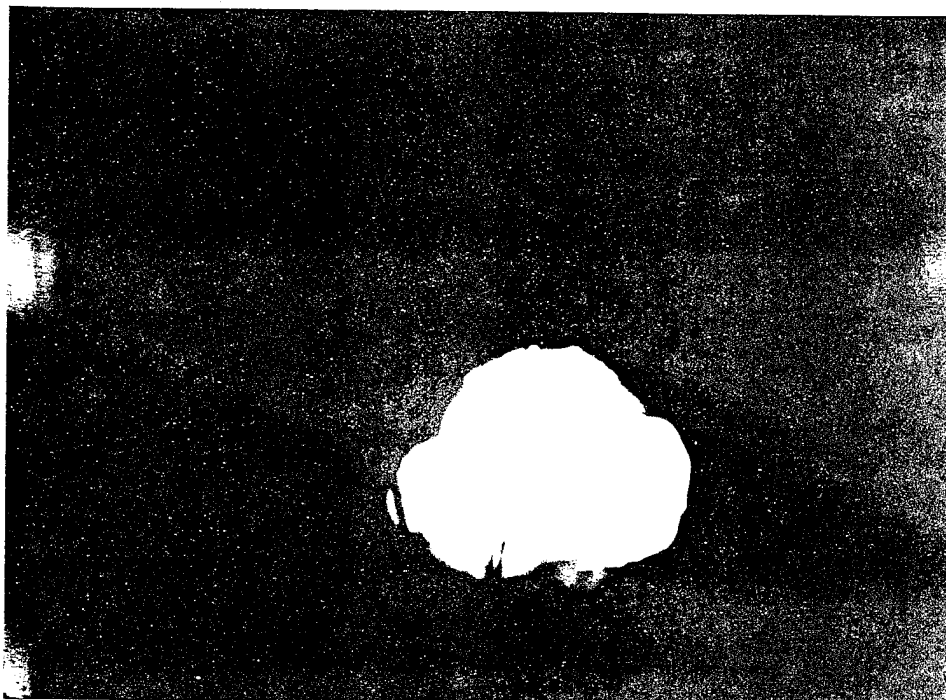
Time: 0.99 msec



Camera: E-1

Station: 3-357

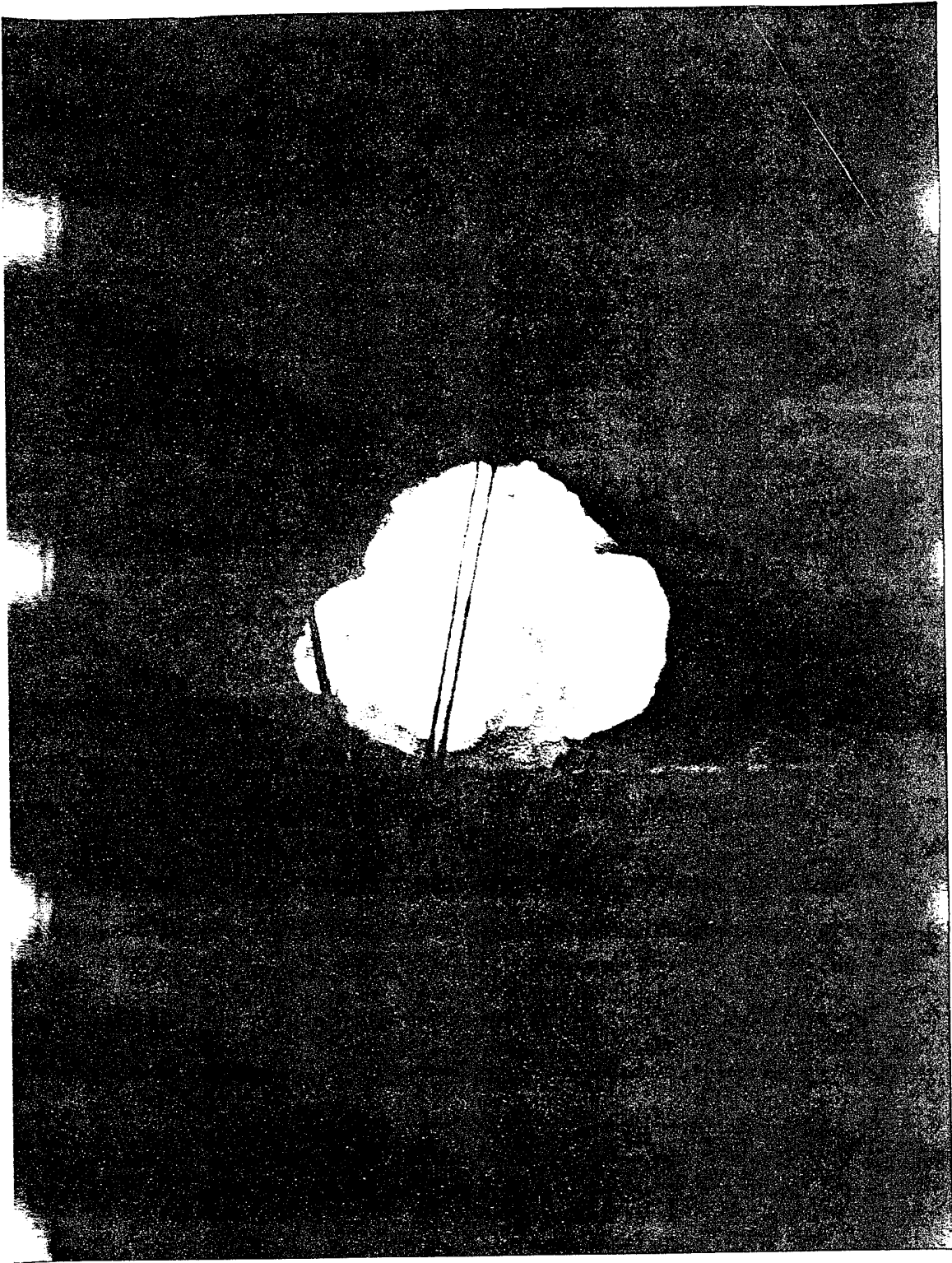
Time: 1.63 msec



Camera: E-5

Station: 3-358

Time: 2.94 msec



Camera: R-4

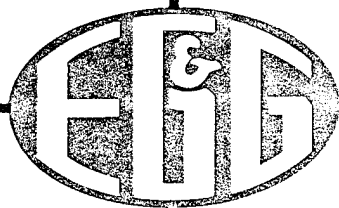
Station: 3-358

Time: 3.15 msec

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